Issue 56
August 2010

ICT Update

a current awareness bulletin for ACP agriculture

CTA

http://ictupdate.cta.int

Remote sensing and web 2.0 tools make water use more efficient in **Mali**

The **Tanzanian** irrigation ministry develops a long-term ICT strategy

Swaziland project uses GIS to identify farmland suitable for irrigation

Irrigation

Contents

ICT Update

ICT Update issue 56, August 21010.

ICT Update is a bimonthly printed bulletin with an accompanying web magazine (http://ictupdate.cta.int) and e-mail newsletter.
Each issue of ICT Update focuses on a specific theme relevant to ICTs for agricultural and rural development in African, Caribbean and Pacific (ACP) countries, and includes feature articles and annotated links to related web resources and projects. The next issue will be available in October 2010.

Publisher: CTA Technical Centre for Agricultural and Rural Cooperation (ACP-EU). CTA is an institution of the ACP Group of States and the EU, in the framework of the Cotonou Agreement and is financed by the EU. Postbus 380, 6700 AJ Wageningen, the Netherlands. (www.cta.int)

Production and content management: Contactivity bv, Stationsweg 28, 2312 AV Leiden, the Netherlands. (www.contactivity.com)

Coordinating editor: Rutger Engelhard / Editor: Jim Dempsey / Copyediting: Tim Woods (English), Jacques Bodichon (French) / Layout: Anita Toebosch / Translation: Patrice Deladrier / Cover Photo: Xinhua / Das Fotoarchiv. / Lineair / Editorial advisory committee: Peter Ballantyne, Oumy Ndiaye, Dorothy Okello, Kevin Painting

http://ictupdate.cta.int

Editorial

ICTs course through irrigation

Figures from the FAO show that irrigation can increase crop yields by up to 400%. Developing a reliable system to water the land all year round gives farmers the chance to plant in the dry season, and grow high-value crops to increase profits and recoup investment costs. But only 4% of farmland in sub-Saharan Africa is irrigated, with similarly low figures for other ACP countries.

Available water sources are already in high demand from rising populations, industrial growth and agricultural expansion. Improved water management is therefore necessary to use existing resources efficiently and to maximise the potential of water. In agriculture, this means developing effective and efficient irrigation systems that can be regularly monitored and regulated.

Remote sensing and GIS (geographic information systems) can provide a unique overview of the land and help planners identify areas suitable for irrigation. Governments in Rwanda, Swaziland and Tanzania, among many others, are using this technology to develop national irrigation schemes. The satellite images and data derived from remote sensing can show soil types, current land use, nearby water sources and the slope of the land on a large, even countrywide, scale.

Irrigation protects farmers against unpredictable weather and helps to preserve valuable water resources

Irrigation engineers can use the data to decide which type of system would work best in specific locations. Field workers can then visit the farmers working in these areas to tell them about the new irrigation plans. Many large-scale irrigation schemes publish details on the web, and keep the local community informed with regular radio programmes.
ICTs are also important for promoting smaller schemes. Radio programmes and websites can explain the benefits of irrigation, or even give farmers details on how to build their own drip or sprinkler irrigation system. Farmers can get weather information sent to their cell phones to help them decide when to run the system, or to turn it off and save water when rain is expected.

With established systems, or those that are newly operational, GIS can monitor the efficiency of water use. Researchers have been working with such a system in the Office du Niger irrigation system in Mali. They analyse satellite data to determine if the water coverage is uniform throughout the system, if the level of water consumption is the same at the start and at the end, and even to measure expected crop yields. The information helps managers identify faults and problem areas without the need for field inspections.

Individual farmers can get help managing their system, too. Researchers in Australia have developed a method to give farmers daily updates on exactly how long to run their irrigation system. The IrriSat project gathers remote sensing data to analyse the water needs of crops in the farms subscribed to the scheme. It also uses local weather details from meteorological stations in the area.

Farmers send an SMS to update the system on how much water they used the previous day. They then receive an SMS to tell them exactly how long they should open the water taps to supply their irrigation system for that day. Farmers recover the costs of their subscription fees by using less water and therefore paying less for it. The IrriSat research team are confident that the system would work well in ACP countries where many farmers are used to getting agricultural information on their cell phones.

Whether the system is large or small-scale, irrigation is helping to increase farmers' profits and improve yields, which contributes greatly to a country's food security. Irrigation also protects farmers against unpredictable weather and helps to preserve valuable water resources. ICTs now play an important role in water resource management, and are becoming crucial to the promotion, development and maintenance of irrigation systems. ■

Maimbo Mabanga Malesu
(m.malesu@cgiar.org) is programme coordinator at the World Agroforestry Centre (www.worldagroforestrycentre.org)

Making technology appropriate

Irrigation has never been common in most of sub-Saharan Africa. The climate has enabled farmers to grow their crops, quite successfully, under rainfed-only conditions. But in recent years the climate has changed and become less predictable and less reliable. Farmers who rely solely on rain to water their crops risk losing all their produce. Irrigation is now an important risk-management tool and many farmers are actively looking for information on irrigation schemes, and how to get the best out of their farms under changing conditions.

Simple drip irrigation schemes are recommended for most small-scale farmers in sub-Saharan Africa. They can collect rainwater on their farm plot or from a nearby source, store it in ponds or tanks, and use either a treadle pump or siphon system to deliver water directly to their crops. Farmers with as little land as half a hectare are successfully using these systems.

Irrigation is also helping small-scale growers become commercial farmers, as it enables them to grow crops throughout the year, even in the dry seasons. They can grow high-profit crops, such as tomatoes, carrots and peppers, and quickly recoup their investment costs. A small-scale drip irrigation scheme (which includes a 120 cubic metre plastic-lined pond, a pump and fencing) typically costs US$800-1000, and most farmers get this back within two to three years.

GEOFF MOORE / REX FEATURES / HH

Support plans

At the World Agroforestry Centre (ICRAF), we have found that small-scale irrigation projects work better with some technical support, especially in the early planning and management stages. And this is where technology can be very useful.

In Rwanda, for example, ICRAF is developing an irrigation master plan using GIS and other scientific and engineering principles. Our team gathered information from across the country on soil types, topography, water resources, current land use, and socio-economic factors. We entered the data on each criterion as a separate layer in a GIS application, and used them for detailed multi-criteria analysis. Based on these parameters, we can accurately pinpoint areas which could be suitable for irrigation. We then visit these areas to do detailed studies, and work with the farmers there – those with only a few acres – to design the best scheme for them.

The next step is to develop pilot projects to see which irrigation methods operate best at the community level, and which are the most cost-effective. The farmers are trained to operate and maintain the system, and will be given support for the first ten years or so, by which time the community will be able to run the system independently.

Integrated technology

GIS is an excellent tool to plan such nationwide schemes, or systems that will cover a whole watershed. You can incorporate a wide range of bio-physical data – on hydrology, soils, slope and vegetation – to get a good overview of a whole region and make a quick assessment based on the available resources. It is also easy to make that information more widely available, to government departments and extension services for example, and to publish it on the web for anyone to use for their own needs.

You need other tools to take the scheme to people living in the area, however. Radio programmes are still very useful for getting information to a large audience, to give details of proposed irrigation systems or to update people on the progress of large-scale schemes in their area. A lot of broadcasters now make recordings of their programmes available to agricultural cooperatives and farmers' working groups, giving them details on the types of irrigation and the suitability of local land. And many projects use bulk SMS messages to get more specific information to farmers.

The most important thing is to design systems – both irrigation and information systems – that are best suited to the environment and the people who will use them.

The first step, therefore, is to improve rainfed agriculture and design methods to give farmers the information they need depending on their local situation. For the longer term, we need to use technology like remote sensing and GIS to identify the best possibilities for irrigation and introduce these systems to make farmers less vulnerable to the increasingly unpredictable weather.

Radio, internet, SMS and other cell phone applications can deliver the information farmers need to adapt to any new systems or practices. Farmers need accurate and timely information, especially as agricultural extension services are so severely underfunded. ICTs are the best way to get information to many rural farmers. It is essential, therefore, that managers and engineers use technology throughout the process to develop well-planned irrigation schemes and give farmers the right information to make well-informed decisions. ■

Feature

Remote control

Managers of the Office du Niger irrigation scheme in Mali are using remote sensing data to analyse the efficiency of the system without having to physically check the infrastructure. The information will help them prepare for future expansion.

In Mali, the Office du Niger irrigation scheme delivers water from the Niger River to a large rice-farming area. The scheme's managers wanted to improve the efficiency of the system to cope with future expansion, and to allow for competition for water resources from the development of nearby commercial sugar cane estates.

In 2009, WaterWatch, an advisory firm based in the Netherlands, tested a low-cost remote sensing-based methodology to analyse the efficiency of the Office du Niger irrigation system. While the remote sensing techniques used in the study had been thoroughly tested by others researchers. This was the first study to assess irrigation performance using only remote sensing technology and with maps providing a high level of detail.

The Office du Niger, situated in the Ségou region of Mali, is one of the oldest and largest irrigation schemes in West Africa. It was developed in the 1920s, and has been in operation ever since. Today, the 80,000 hectares of rice fields provide approximately 465,000 tons of rice each year – around 40% of the national production – which makes this farmland extremely important for Mali's food security.

Rice grows mainly during the rainy season (approximately June to December). Water is abundant at this time, and the entire irrigation network is continuously filled with water. Farmers can irrigate as long as they have paid a seasonal contribution (a *redevance*). In recent years, the government has promoted a second rice season (March to June) by lowering the *redevance*.

The entire system is divided into five administrative zones, each responsible for land and water management in their part of the irrigation scheme. The zones are subdivided into *casiers*, which are further sub-divided into blocks representing, on average, ten farmers. Each farmer is responsible for the irrigation and drainage of an individual rice field.

Even out

In an effort to keep assessment costs low, the researchers used images from the Landsat7 satellite (among others). The Landsat programme has been gathering high-resolution satellite images since 1984, and all archived material can be accessed for free from the United States Geological Survey global visualization (Glovis) website. The researchers also made use of information from the nearby Ségou meteorological station, including air temperature, humidity and wind speed data.

The WaterWatch team used the data to look at four factors in their assessment of the Office du Niger scheme: cropping intensity – a measure of the 'greenness' of an area; productivity of water – the rice yield compared to the amount of water used; uniformity – whether the water is evenly distributed throughout the system, and; head-tail performance – a comparison of the amount of water consumed at the start of the irrigated area (head) and at the end (tail).

Analysis of the satellite images showed that there was vegetation in much of the Office du Niger area during the main growing season, but also during the second growing season. Very little rain falls at this time, so the farmers must have been using the irrigation system. This suggests that reducing the *redevance* has allowed farmers to grow a second rice crop.

The study showed that rice yield varies between the five administrative zones. One explanation is that the water is unevenly distributed throughout the system. An ideal irrigation system distributes water equally to all users, but under practical field conditions several factors – such as soil type, water quality and fertilisation – affect water consumption in different fields and zones.

Low yields can also be an indicator of problems with the irrigation system. Poor maintenance of canals and structures, inadequate management and illegal water use can, for example, mean that farmers with crops at the tail of the schemes have lower yields than those at the head. The study revealed that estimated yields at the tail end of the Office du Niger system were 18% lower than at the head end.

In one *casier*, the study found high yields at the head and tail of that system, but lower yields in the middle. According to the zone manager, the *casier* receives sufficient water for everyone, but due to the bad design of a weir located halfway along, less water reaches the fields beyond that point. The increase in water consumption at the lower end of the *casier* is caused by excess drainage water gathering there.

The research suggests that the lower yields at the tail ends can, at least in part, be attributed to irrigation water management, although factors such as deterioration of water quality may also play a role. The analysis shows that there is significant scope for improving the productivity of the water resources in the Office du Niger system. The construction of a well-functioning drainage network, for example, could lower salinity levels, reduce flooding and improve crop yields.

Sander J Zwart (s.zwart@cgiar.org) is a remote sensing and GIS specialist with the Africa Rice Center (www.warda.org), **Lucie M C Leclert** (l.leclert@gmail.com) is an irrigation specialist/social scientist at Euroconsult MottMcDonald, and **Wim Bastiaanssen** (w.bastiaanssen@waterwatch.nl) is director of WaterWatch (www.waterwatch.nl)

CYNTHIA BOLL / HH

Working knowledge

The WaterWatch team worked closely with the irrigation scheme managers to gather feedback, discuss the limitations and advantages, and find ways to refine the assessment methodology in the future. In the case of the *casier* with the faulty weir, for example, the management knew about the problem, but they found that the remote sensing analysis helped to show the physical impacts on the crops.

The study confirmed many of the managers' perceptions of the problems affecting system performance. The water reaching crops during the rainy season, for example, is higher than the actual demand, causing low efficiency of irrigation water application, water logging and water losses to drainage areas. By scheduling water supplies to match demand, managers can improve efficiency and water productivity.

However, incorporating remote sensing data into the routine monitoring and evaluation work of managers would require changes to the current system and an investment to train staff to interpret the images. The methodology used by the researchers would also need some improvements to provide more accurate results.

For example, it was not possible to distinguish between rice crops and other plant types – weeds, for instance – in the analysis of the images used in this study. Future research could focus on improved methods to discriminate rice from non-rice vegetation, and on the accurate estimation of yield from rice-only producing areas. The results of the study could also be linked to data from soil maps, surface water flows and water quality analysis to determine the causes of low yields.

During the discussion of the study, the Office du Niger and donor agencies showed great interest in the results and possibilities that remote sensing offers. The managers saw a chance to identify and define priority areas for rehabilitation, and also to map crops that make use of the irrigation system but which are not part of the official *casier* areas.

WaterWatch has applied the methodology to agricultural areas all over the world, working with different crop types and environments. This gives the team the chance to continually review and adapt their techniques to give farmers a more accurate view of the strengths and weaknesses of their irrigation systems. And Water Watch now uses web 2.0 tools to make study results more easily available to irrigation managers.

For recent projects in Egypt and South Africa, researchers have integrated soil quality and remote sensing data to be viewed in Google Earth. Irrigation engineers can use the application to get a high quality, detailed picture of the land, and identify areas where water is wasted and where more irrigation is needed. By keeping the cost as low as possible and making the data readily available, WaterWatch hopes their methodology can be applied to more irrigation schemes, and that eventually farmers start using remote sensing data as a routine part of their work. ■

Related links

Water use in the Western Cape vineyards
WaterWatch has produced Google Earth maps showing water use in wine grape farms in the Western Cape, South Africa.
➜ www.waterwatch.nl/grapes

Office du Niger
➜ www.office-du-niger.org.ml

United States Geological Survey Glovis image archive
➜ http://glovis.usgs.gov

A balanced delivery

Irrisat-SMS combines satellite data, information from local weather stations and feedback from farmers to deliver daily, detailed irrigation scheduling advice via SMS.

Case study

Irrisat-SMS is an irrigation water management service that uses high-level technology to deliver information to farmers. Developed in New South Wales, Australia, by CSIRO Land and Water, the system converts data from satellite images and weather stations, and sends this information as an SMS to farmers' cell phones. This tells them exactly how long they should run their water pump in order to replenish the water delivered to the crops by their irrigation system.

Richard Soppe (richard.soppe@csiro.au) is an irrigation scientist with CSIRO Land and Water (www.clw.csiro.au)

The service sends one SMS per day to each subscribed farmer. As part of the subscription, farmers are asked to send back information to the system, including the actual time their irrigation system has been running that day, and data about any rainfall on their farm. A central computer keeps track of each specific farm's water use.

The system collects satellite images throughout the season to monitor crop development on the farms that have signed up for the service. The light reflected from the vegetation and land is captured by sensors on board the satellites and converted using remote-sensing software to show crop vigour. This can indicate the rate of evapotranspiration from a crop.

Weather stations in the farmers' region collect data on temperature, wind speed, solar radiation and relative humidity, and automatically deliver the data to the central Irrisat-SMS database. The weather information, combined with the evapotranspiration data, determines the conditions for actual water consumption by the crops on a particular farm.

The daily water consumption of a crop is usually expressed in millimetres (or inches) of water, but that does not mean that farmers know immediately how much water they need to apply to their fields. To provide farmers with precise, customised information, Irrisat-SMS researchers must visit and evaluate each farmer's irrigation systems.

For drip irrigation, which is extensively used in the service's test area in New South Wales, researchers used catch-cans and stopwatches to measure the actual water-flow rate through a number of drip emitters randomly selected in a field. The catch-can collects all the water that flows out of the drip emitter for a specified length of time. These data provide the farmers with information about the uniformity of water flow through their drip system, and tells them if the system needs maintenance or replacement. The data also inform farmers about the actual application rate of their irrigation system, i.e. how much water is delivered to the plants. The application rate is entered into the Irrisat-SMS database, and is then used to calculate the time that the pump needs to run to apply exactly the right amount of water consumed by the crop. It is this information that is sent daily to the farmers via SMS.

Adaptable tool

Irrisat-SMS has already delivered irrigation advice to farmers growing many different types of crops in a wide variety of conditions. Some crops and situations require extra work to gather the right information to ensure that farmers receive the maximum benefits from the service. The database has, therefore, been developed to be flexible and take special considerations into account.

In the Griffith area of New South Wales, for example, the farmers growing grapes for red wine have different irrigation needs to those growing grapes for white wine. White grape growers try to maximise their production, while the red grape growers manage their irrigation system to optimise quality as well. The red grape growers use 'managed stress-induction' techniques in the second part of the growing season.

The Irrisat-SMS database contains information on the target crop, and provides adjusted crop water requirement information when possible. Adjustments were also needed for periods early in the season, when the canopy cover of the grape leaves was low, and ground cover of grasses, weeds or inter-row crops affected the crop-vigour indications from the satellite data.

Cotton growers in Australia used the system for several different fields in the same farming enterprise. Each field requires separate irrigation information, so to avoid an excessive amount of messages sent to a cell phone, the developers produced a system to deliver the same information on the web – Irrisat-Web. In this version, the farmer is presented with a graphic visualisation of their fields, the water balance information, and the cumulative run-time required to replenish the water used by the irrigation system.

The web version is available to all farmers signed up to Irrisat-SMS, but many do not use it; internet access is very limited in some rural areas of Australia, while cell phone coverage tends to be better. Farmers in another of the service's test areas, close to Sydney, preferred to use Irrisat-Web. These users had better access to the internet, but many were also hobby farmers with small fields. They wanted to access the information at a time that suited them, rather than have an automatically scheduled SMS delivered to their phone early every morning.

The main challenge for this group of farmers was in the farming system, which often included a large variety of non-native vegetables, growing intermixed and in different stages of crop development. Most of the vegetables were shallow rooted, thus having a limited soil-water storage capacity, which also required a high frequency in irrigation. Since a water-balance approach – replenishing the water used for irrigation on the previous day – would require a lot of feedback from the farmers, a slightly different approach was necessary.

The effort involved to send all this data back to the system would probably outweigh the benefits, so Irrisat-SMS was adjusted to send farmers an SMS with a maximum daily water requirement for the specific crop area.

Personal connection

Throughout the development process, the Irrisat team collected detailed survey data from all the subscribed farmers. Most farmers reported several benefits in the delivery of irrigation advice via SMS. Several long-time growers see the service as a confirmation of their irrigation scheduling based on years of experience. Others, especially growers that have recently changed technology or farming approach (from furrow to drip irrigation or from vineyards to orchards) use the information as a guide and follow the advice as closely as possible. A third group use the information as a benchmarking tool, as Irrisat-Web offers anonymous comparison with other growers in the same sector.

It is well known that the total available seasonal water and crop yield are related; a lack of water usually results in lower yields. However, irrigation is only one aspect of any farming enterprise and other factors must be considered, including crop establishment, pest and disease management, the availability of farm equipment or labour at the right time in the season, and crop commodity prices.

Water is, therefore, not always the determining factor in crop yield. Not all growers followed the advice provided through the Irrisat-SMS service. Some deliberately under-produced due to low crop prices or a lack of guaranteed contracts for the crop, while others were not able to follow the advice due to a limited water supply on the farm (for example, farms irrigating from a farm dam, which is wholly dependent on rainwater collection during the season).

Cell phones have developed into a highly accessible tool worldwide, and provide the gateway between online systems and offline farms

The Irrisat-SMS service has, so far, only been applied in irrigated areas in Australia, although there are plans to introduce it in some Asian countries. The use of cell phones to deliver irrigation information is especially suitable for ACP countries too, where cell phones are widely used. Cell phones have developed into a highly accessible tool worldwide, and provide the gateway between online systems and offline farms.

The satellite input used in the Irrisat service, combined with automated weather station information, allows regular, remote monitoring of rural areas. Contact and feedback from the user appear to strengthen the tool, and provide farmers with a flexible irrigation management system tailored to their precise needs. Experience after several years of trials indicates that simple phone messages, based on information from high-tech sources, have a great potential for farm and water extension services throughout the world. ■

XINHUA / DAS FOTOARCHIV / LINEAIR

A plan for the future

Tanzania's Ministry of Water and Irrigation has developed an ICT strategy, which includes using GIS, radio and cell phones, to deliver irrigation and water services.

Case study

If someone living in a remote part of Tanzania wants information on what the government is doing to bring irrigation to their region, they have to take a long trip to the Ministry of Water and Irrigation (MoWI) and ask a member of staff. Aware that this is a problem for many people, the ministry is now developing its use of ICTs to give the public a better understanding of exactly what it does.

In line with the national e-government policy, MoWI has developed a detailed ICT strategy that covers each of its offices and departments. As well as providing information to the public, the new plan sets out policies for using technology to streamline daily working practices and deliver more efficient services.

'Previously, each department was responsible for its own equipment and processes,' says Joash Nyitambe, head of the ICT unit at MoWI. 'We were wasting a lot of resources on things that could be shared or integrated between offices. Also, we didn't have a clear picture of what resources we had or what we would need in the future. That's why we had to develop a clear plan.'

The ministry's ICT strategy details how it will use technology from 2010 to 2014. For irrigation, this means using remote sensing and GIS technology to gather information on soil quality and available water resources. This will help managers and engineers identify areas suitable for irrigation.

'We are developing a system to capture data on all the water points and irrigation services in the country,' says Nyitambe. 'We need to update the information we currently have so that we can plan and decide where to invest in the future. We have a project to visit each water point with GPS receivers to record the coordinates of every location, and we are investigating the best methods for field officers to collect other data, such as the condition of water pumps and the types of crop being grown. Cell phones could be very useful for gathering this kind of information; they can be carried easily and can send back data via the cell phone network without the need for field officers to return to the office every day.'

Targeted data

The ministry will also look at levels of internet and cell phone connectivity throughout the country. By mapping the availability of this technology, communications specialists can then decide on the best ways to reach people living in specific areas. For example, the ministry can use SMS to inform

Joash Nyitambe (jnyitambe@mowi.go.tz) is head of the ICT unit at the Tanzanian Ministry of Water and Irrigation (www.mowi.go.tz)

people in places where cell phones are commonly used, and make radio programmes to deliver information to people in areas with no cell phone coverage or internet access. Those with good internet connectivity can be kept up to date with e-mails and posts on MoWI's website.

'We've had very encouraging results from previous projects that delivered agricultural information on the web,' says Nyitambe. 'There are still areas of the country with unreliable cell phone coverage, but some rural villages are very advanced and have good internet access. We hadn't expected such a good response to our internet services from these areas. It showed us that we have to adapt our information delivery depending on the location, and use the most appropriate method and technology to keep people informed.'

The pace of change in the technology sector presents its own challenges to anyone producing a long-term national ICT plan

This combination of a wide range of data will help MoWI draw up detailed plans specific to the location where future irrigation schemes will be installed. Managers will be able to use GIS and field information to determine which sites will be a priority and what kind of irrigation system should be installed. They can use the data on technology coverage to decide on the best way to inform the local population of new installations and develop methods for obtaining feedback.

The ministry will also use integrated computer networks to tackle water supply issues, for example, reforming the manual billing system. Water users will be able to get a better overview of exactly how much water they use and what they are paying for. The process will be more efficient, allowing the ministry to reinvest any savings into providing better basic services. It may also be possible, in the near future, to send water bills directly to customers' cell phones and enable them to pay through mobile banking systems. This would save people from having to visit their local authority to collect and pay their bills.

Regular reviews

It can take a long time to develop such a detailed strategy – eighteen months in MoWI's case. First, staff from each department had to be consulted, and the strategy team had to decide which ideas they could use and which did not fit in with the overall plan. The next step was to present the details to technical staff, management and elected officials for further discussion. And not just officials from the Ministry of Water and Irrigation, but related ministries too.

'The administrative issues took up a lot of time,' says Nyitambe. 'But we involved as many people as possible from the very beginning, inviting them to meetings or even through informal talks. When we finally called everyone together to discuss our paper, they were already aware of what we were doing and why. That helped to make the process go more smoothly, and although there were inevitable changes and suggestions that we had to incorporate, we managed to reach a consensus fairly quickly.'

But ICTs develop rapidly. Software companies regularly upgrade operating systems, manufacturers produce faster and more efficient computers and yet another cell phone application becomes available for download. The pace of change in the technology sector presents its own challenges to anyone producing a long-term national ICT plan.

'That makes it very difficult to talk about specific types of technology in the strategy,' says Nyitambe. 'Instead, we have to look at functionality. We need to determine exactly what we need in order to develop our services. We will then revisit the plan annually to decide which kinds of technology we will use to make sure we stay on track to meet our goals.'

The ministry's managers have to be realistic, however. They know that the new strategy will not please all of their employees. 'Some people get worried when you start talking about introducing new technology,' says Nyitambe. 'Many think it means they will lose their jobs, when in fact this is hardly ever the case.

'Making greater use of ICTs will certainly bring change to the ministry, though. It will mean some retraining. It will also mean reorganising personnel into new positions and even new offices. This can be a big shift in the mindset of some people, and we must be aware of that. So as well as adopting new technology, we also have to adopt new change management practices to make sure people understand the process.'

The initial cost of investing in technology and implementing it across the entire country can be high. However, MoWI's executives are sure that the programme will become cost-effective through more efficient cost-recovery operations, the integration of resources and the streamlining of services. Having a comprehensive plan for the future also helps to attract donor funding. But donor agencies have their own plans, and having a clear strategy set out on paper can appear inflexible.

'Donors generally like it if you can spell out exactly what you want and explain how you will use the money,' says Nyitambe. 'But many donors have already identified the areas where they want to invest and if our plan doesn't match theirs, then it can be a big challenge to find the right funding.'

After all their hard work to put together such a detailed plan, staff at the ministry face another potential challenge: Tanzania is expected to hold elections in October 2010 and a new minister could arrive with very different priorities. But this does not discourage Nyitambe; he's convinced that the new ICT strategy will help the ministry provide irrigation and better water services to the people. 'We cannot put off making plans just because the future is uncertain. In fact, that is exactly why we need such a strategy – to plan and be ready for the changes that may come.' ■

JOERG BOETHLING / LINEAIR

Water, soil and data

A project in Swaziland uses remote sensing and GIS to identify irrigable farmland. The data are analysed to improve the efficiency of project management processes.

Case study

Droughts are frequent in the Lower Usuthu region of Swaziland. The semi-arid climate makes it difficult for smallholder farmers to grow enough food for themselves. Average annual incomes are low – around US$ 100 per person – and earnings are unlikely to increase if farmers rely solely on rainfall to water their crops.

Research in the region, however, suggests that irrigating the land could result in crop yields comparable to those found on nearby commercial farms. For example, several farmers have recently started small-scale irrigation schemes to grow sugar cane, and have managed to obtain good yields (105 tons per hectare).

Based on these findings, Swaziland Water and Agricultural Development Enterprise (SWADE), a local state-owned company, is working with several local and international partners to develop a large-scale irrigation scheme for the area. The main infrastructure, including three dams to store flood flows diverted from the Lower Usuthu River, is being constructed as part of the Lower Usuthu Smallholder Irrigation Project (LUSIP).

Doctor Lukhele (lukheledmp@swade.co.sz) is chief executive officer of Swaziland Water and Agricultural Development Enterprise (www.swade.co.sz)

The project will initially provide irrigation water to 2600 households, covering 6500 hectares of land. For the first time, farmers in the area will be able to move away from subsistence agriculture and produce cash crops, which could increase their income. The first 800 hectares are now being irrigated, while work to bring the scheme to a further 5000 hectares is underway.

Clear position

Remote sensing and (GIS) have been crucial in the planning and management of the project. The data gathered are used primarily to inform farmers on how to make the best use of the newly irrigated land. The GIS data, for example, are analysed to identify areas which can be irrigated, show soil types and plot existing water sources. The team then visit the farmers to give advice on which crops to grow on the irrigated land, depending on the specific local conditions.

SWADE uses geographically referenced data of the area to produce maps pinpointing the households that need special attention; those with very low incomes or situated on land with especially poor crop yields. They also use the maps to outline current land-ownership patterns and to plot community facilities, such as schools and clinics.

The mapping information helps LUSIP staff to give advice to the traditional land authorities when planning future land use. The data can help them designate grazing and rangeland areas, resettle people onto irrigable land, and develop guidelines for water supply, roads and electricity.

As the project has progressed, the team have been updating the maps and GIS data to keep track of their activities. They now note the exact locations of households on land receiving irrigated water and which have already benefitted from the project's services, including training and crop advice. Knowing exactly which farmers are participating in the scheme, and who has already been contacted, means managers can monitor progress, plan future activities and avoid duplication or wasting resources by visiting homes not directly affected by the project.

Growth experience

Another important part of LUSIP is to keep the public informed about the project benefits and progress. Face-to-face communication is the main method of informing the people living in the irrigated areas. Staff regularly organise community meetings and visits to traditional leaders and farmers to keep them up to date on the latest project developments, and to give training courses on new farming techniques and irrigation technology.

The project team arrange for farmers to visit other parts of the country to learn methods that might be applicable to the new crops they will grow. LUSIP also has a demonstration plot to display and test the profitability of different crops. A specially developed information centre provides a space for workshops, and gives farmers an opportunity to ask specific questions and receive feedback.

The information given at training courses, workshops and meetings is supported by radio, television and newspaper reports. Radio is a particularly important outlet for the project, with staff regularly taking part in national radio programmes to give farmers updates on new agricultural techniques and market opportunities. The radio reports also inform the wider public about the project and the general benefits of irrigation for the country.

Throughout the project, SWADE has used information management systems to help them refine and record the processes involved in introducing irrigation to the Lower Usuthu area. Keeping accurate records of the methodology will ensure the project can be efficiently replicated in other suitable areas of Swaziland. The organisation also encourages staff working on similar projects throughout Africa to visit LUSIP and share ideas, in the hope that others can learn from their work and develop irrigation elsewhere on the continent. ■

Information for irrigation planning

There are a wide range of resources available on the web to help agricultural extension services, NGOs and cooperatives develop and maintain irrigation schemes for small-scale farmers.

In its effort to provide information on global agriculture, the Land and Water Division of the Food and Agriculture Organization (FAO) has developed several information systems relating to water and irrigation. All are available for free on the web.

AQUASTAT

www.fao.org/nr/water/aquastat/main/index.stm

This project collects and analyses water and agriculture data from around the globe. Select the country from the drop-down menus on the homepage to get:

- country profiles, with details on climate, rainfall, food security, water resources and water management policies;
- country fact sheets, giving land area, water use, irrigation and drainage development data;
- water balance sheets, including information on the long-term averages of the country's renewable water resources, with figures for precipitation, surface water and groundwater.

The site also has a database of dams and reservoirs in Africa, the proportion of total water resources used in each country (millennium development goal indicator 7.5), and a range of thematic maps showing, among other things, renewable water resources per inhabitant, proportion of renewable water resources withdrawn for agriculture, and cultivated areas under irrigation. All maps can be downloaded as pdf files.

Global map of irrigation areas

www.fao.org/nr/water/aquastat/irrigationmap/index.stm

Part of the AQUASTAT programme, this map is useful to anyone planning an irrigation scheme as it gives details of areas already equipped for irrigation. Visit the website and click on the link 'Interactive map' in the left-hand sidebar. A new window will open showing a world map with colours indicating the percentage of land irrigated. Click on the icon of a small magnifying glass with a +, in the top-left corner, to zoom in on a specific area. Click on the globe symbol to go back to the full view.

The map is available for download as either a high-resolution pdf file (7.7MB) or low resolution (1.9MB), both of which can be opened with Adobe Reader. Perhaps the most useful way to view the map is in Google Earth, if you already have the program installed on your computer (or download at http://earth.google.com). Click the link 'Map in Google Earth' from the main page of the irrigation map website, then click 'save' to save this small file to your computer (3kb). Open the file in Google Earth to see the coloured layer indicating the percentage of irrigated land (the program might take a few seconds to adjust when zooming in). There are three other versions of the map available, but these can only be used with GIS software:

i) as an ASCII-grid showing the area equipped for irrigation as a percentage of the total area (2.4MB zipped);
ii) as an ASCII-grid showing the area equipped for irrigation in hectares (2.3MB zipped);
iii) as an ESRI shape file (12.2MB zipped).

The data can also be viewed as a list from the irrigation map homepage. Click on the link 'irrigation by country', then choose the country from the drop-down menu.

CropWat

http://www.fao.org/nr/water/infores_databases_cropwat.html

CropWat is a computer program which calculates the water and irrigation requirements of a crop. It can be used to work out irrigation and water balance schedules depending on the climate and soil type.

The latest version, CropWat 8.0, is available for Windows operating systems 95, 98, ME, 2000, NT, XP and Vista. To download the latest version for free, click on the 'download' link in the right-hand sidebar and complete the form with an e-mail address and job title. You can then download a compressed file to install the application (3.4MB). Double click the file to install and run the program.

FAO has a detailed example of how to use the software, which can also be downloaded from the site. Click the 'Example of CropWat 8.0 use' link in the sidebar (1.3MB pdf file).

To use the software effectively, you need to enter local climate data for each month of the year, including maximum and minimum temperatures, humidity, rainfall and sun hours. If the exact data is not available for your area, FAO provides a

MELTERS/MISSIO/DAS FOTOARCHIV/LINEAIR

database, compatible with the software, which contains climate details from over 5000 weather stations. Download **ClimWat** by clicking on the link in the left-hand sidebar of the CropWat website. From the same page you can download another useful program, the **ETo Calculator**, which calculates the evapotranspiration rate that is also required for the CropWat program. ■

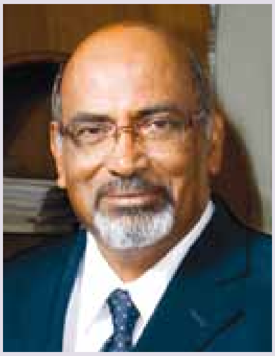
Related resources

Irrigation Equipment Supply
A database of irrigation equipment suppliers and manufacturers worldwide.
➜ **www.fao.org/landandwater/ies/**

Climate Atlas Web Query
From the International Water Management Institute, CAWQuer provides climate summaries for specific locations based on latitude and longitude coordinates.
➜ **http://wcatlas.iwmi.org/Default.asp**

WCA infoNET
Contains a wide range of information on water conservation and the use of water in agriculture.
➜ **www.wca-infonet.org**

The Virtual Centre for Water in Agriculture
Promotes water and soil resource use in agriculture.
➜ **www.ciseau.org/index.jsp**



Stanley Rampair
(stanleyr@nicjamaica.com)
is the chief executive officer
of Jamaica's National
Irrigation Commission
Limited
(www.nicjamaica.com)

Efficiency in full flow

Few farmers use irrigation. What are the main limiting factors?
➜ Irrigation has always been fairly expensive option for small-scale farmers. You also need the right environment: for instance, the gradient of the land cannot be too steep and there must be an available water source. These requirements rule out irrigation for many farmers.

To take Jamaica as an example, we have fewer than 500,000 acres of mechanisable irrigable land out of a total of 2.7 million acres. The rest of the land is subject to erosion, is unsuitable for mechanisation, or has some other land management problem.

Farmers who do not have a nearby water source could try rainwater harvesting, but this too has limitations. You need to have rain for one thing; at least 1000 mm per year to make it worthwhile.

How can farmers benefit from irrigation?
➜ Irrigation can greatly improve yields and guarantee crops. Farmers don't need to worry if there will be enough rainfall; they know their crops will get enough water. It provides a kind of reassurance.

And irrigation can turn unproductive land into land where you can grow profitable crops. This has been particularly important for us in Jamaica where, like many other tropical countries, we have a bi-modal rainfall distribution. That means we have two wet seasons, but they come quite far apart, with dry seasons that can be severe. Our rainfall usually peaks in May and October, and many farmers use this to water their crops, but it is very risky. The rain is unpredictable; it can come a month later than expected in some areas, which makes cultivation, especially of short-term crops, almost impossible.

It is important that the irrigation method suits the environment and the crops. In Jamaica, we have been using flood irrigation for sugarcane for more than 120 years. But flood irrigation is only 40-50% efficient in Jamaica. In other words, roughly half the water is lost. A sprinkler system is slightly better, at about 60-65% efficiency, but a good drip irrigation system can be 90% efficient. If farmers using a system running at 45% efficiency change to a system with 90% efficiency, they can cover twice as much land using the same amount of water.

FRISO SPOELSTRA / HOLLANDSE HOOGTE

How can ICTs help in the delivery of irrigation?
➜ GIS can be very useful for planning irrigation schemes, to find suitable irrigable land and identify the available water sources. But you need quite a high level of expertise to apply this technology and it's not readily available for regular use by small-scale farmers.

What are becoming increasingly available, however, are soil moisture sensors. These are placed directly into the soil and are connected to a controller that is linked to a solenoid valve. The electronic sensor detects the soil moisture level, and when it gets too low – when the soil becomes too dry – it sends a signal to the controller, which opens the valve to irrigate the soil. When the soil has had just enough water, the sensor detects this and sends another signal to close the valve.

These soil sensor systems are becoming much cheaper, to the point that they are affordable for many small-scale farmers. The controller costs around US$100, the valve is around US$30, and you can buy a simple soil moisture sensor for approximately US$120. The farmer uses less water per year and is able to recover the investment costs very quickly.

Using soil moisture sensors to control the irrigation system is very efficient. We have had some very interesting results with Irish potato crops. Many people think potatoes are an expensive crop because of the amount of water they take up, but our tests have shown that, with a carefully controlled irrigation system, the cost of water is less than the amount farmers usually spend on fertiliser.

How can ICTs inform farmers about irrigation?
➜ It depends on the farmers' access to technology. Cell phones can be useful to send out information on market prices and advice on good agricultural practices. But not every farmer has a cell phone, or can read and understand the messages. Face-to-face communication is therefore still very important, either in the field or in formal sessions where farmers visit a local training centre, for example. Practical demonstrations are often the most important means of getting information across, especially when it comes to explaining complex systems such as drip or sprinkler irrigation systems.

How can government ministries and extension services use ICTs to promote irrigation?
➜ ICTs help us to develop links to other agricultural professionals, in the region and throughout the world. We are developing contacts with other countries that also need to use irrigation to improve crop production, so we can use technology to communicate and learn from each other. Israel, for example, is probably the world leader in irrigation technology and we can learn a lot from their methods.

All of these technologies have really helped to make great progress in agricultural production over the last few years. And the use of technology in agriculture will continue to increase in the future; to gather data, monitor inputs and evaluate production helps us to make efficient use of resources to get much better yields. ■